ENVIRONMENTAL AND RADIOACTIVE EFFLUENT MONITORING ANNUAL REPORT 1973

By

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ABSTRACT

Environmental and radioactive effluent monitoring at Atomics International is performed by the Operational Safety and Waste Management Unit of the Health, Safety and Radiation Services Department. Soil, vegetation, water, and air are routinely sampled up to a distance of 10 miles from Atomics International sites.

The environmental radioactivity reported herein is attributed to natural causes and to nuclear weapons testing, rather than to Atomics International operations.

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I. SUMMARY

Atomics International Division of Rockwell International Corporation has been engaged in atomic energy research and development since 1946. The Company is engaged in the design, development, fabrication, and testing of components and systems for central station power plants, and fabrication of nuclear fuel for test reactors. The Company is also engaged in programs for development and fabrication of systems for stack gas SO_2 control, gasification of coal, and solid and liquid waste disposal.

The Company occupies modern facilities in Canoga Park, California, approximately 23 miles northwest of downtown Los Angeles (Figure 1). The 290-acre Nuclear Development Field Laboratory (Figure 2), which includes both AEC and Rockwell International owned facilities for the support of nuclear operations, and liquid metals systems testing, is located in the Simi Hills of Ventura County, approximately 29 miles northwest of downtown Los Angeles. The location of the above sites in relation to nearby communities is shown in Figure 3.

Programs conducted during 1973 include the operation of reactors for neutron radiography and research, a hot cell, and a radioactive material disposal facility. In addition, fuel manufacturing involving normal and enriched uranium was conducted during the year. A number of facilities, including several deactivated reactor facilities, are maintained in standby condition.

The basic concept of radiological hazards control at Atomics International requires adequate containment of radioactive materials and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a measure of the effectiveness of the Company's radiological safety procedures and of engineering safeguards incorporated into facility designs.

Environmental sampling stations located within the boundaries of Atomics International's sites are referred to as "on-site" stations. The remaining stations, located within a 10-mile radius of the sites, are referred to as "off-site"

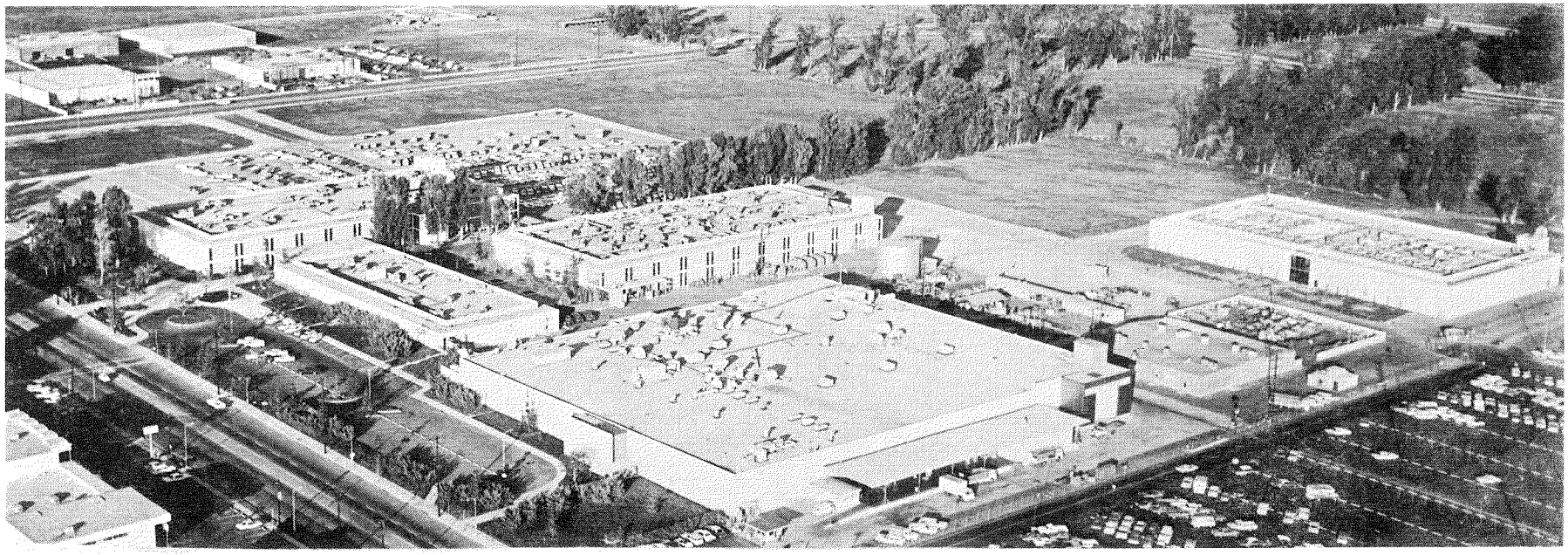

Figure 1. Atomics International Headquarters

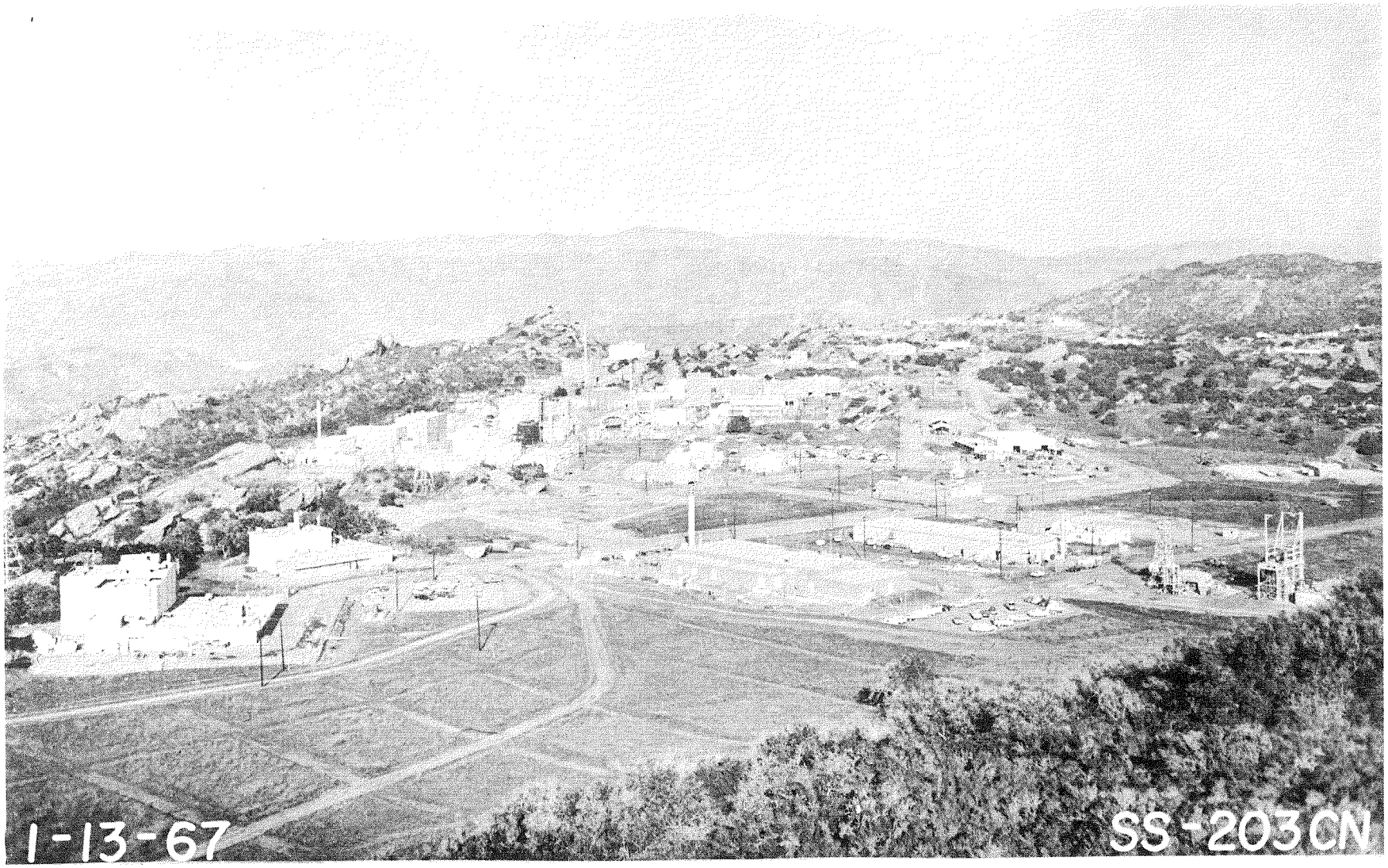

Figure 2. Atomics International Nuclear Development Field Laboratory

stations. The on-site environs of the Atomics International Headquarters and Nuclear Development Field Laboratory (NDFL) facilities are sampled monthly to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The off-site environs are sampled quarterly. Continuous on-site environmental air sampling provides information concerning long-lived airborne particulate radioactivity. A background gamma radiation monitoring program, utilizing thermoluminescent dosimetry (TLD), was begun in 1971.

This report summarizes environmental monitoring results for 1973. A comparison of 1973 results with previous years appears in the Appendix.

A. ENVIRONMENTAL RADIOACTIVITY DATA — 1973

The average radioactivity concentrations in soil and vegetation samples are presented in Tables 1 and 2.

Process water used at the NDFL is obtained from Ventura County Water District No. 8 and distributed on-site by the same piping system previously used when process water was supplied by on-site wells. Pressure is provided by elevated storage tanks and storage reservoirs on-site.

While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the pipe system is sampled monthly at two locations. The average process water radioactivity concentration is presented in Table 3.

TABLE 1

SOIL RADIOACTIVITY DATA — 1973

Area	Activity	No. Samples	Gross Radioactivity (μCi/gram)	
			Average Value (95% Confidence Level)	Maximum Observed Value
On Site	α	144	$(5.7 \pm 1.4)\ 10^{-7}$	9.1×10^{-7}
	β-γ	144	$(2.5 \pm 0.086)\ 10^{-5}$	3.0×10^{-5}
Off Site	α	48	$(5.1 \pm 1.3)\ 10^{-7}$	8.9×10^{-7}
	β-γ	48	$(2.4 \pm 0.085)\ 10^{-5}$	2.7×10^{-5}

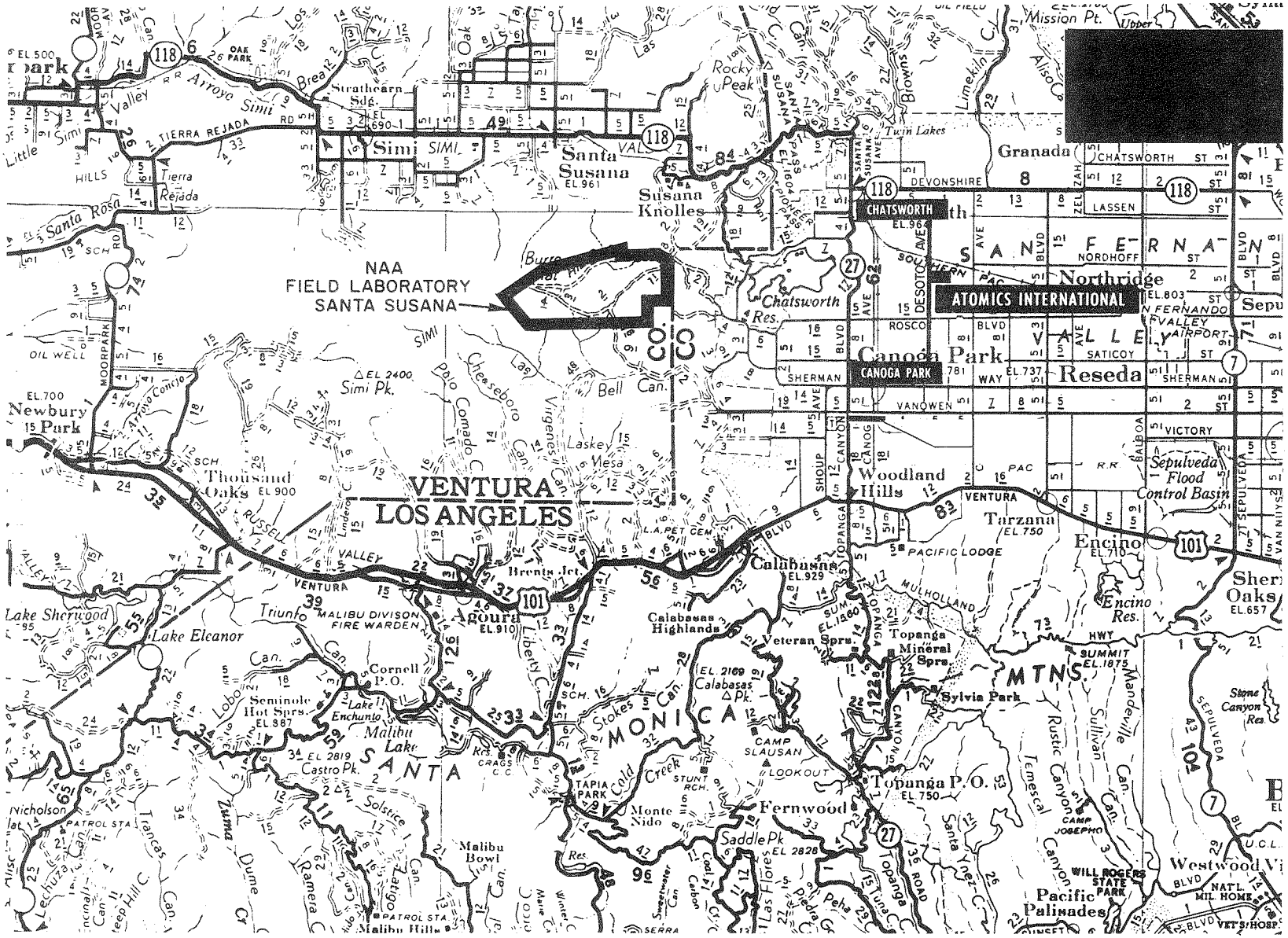

Figure 3. Map of Headquarters and Nuclear Development Field Laboratory Environs

TABLE 2

VEGETATION RADIOACTIVITY DATA – 1973

Area	Activity	No. Samples	Gross Radioactivity (μCi/gram)		
			Dry Weight Average Value	ASH Average Value (95% Confidence Level)	ASH Maximum Observed Value
On Site	α	144	$<4.4 \times 10^{-8}$	$<(2.4 \pm 1.5)\ 10^{-7}$	1.4×10^{-6}
	β-γ	144	2.50×10^{-5}	$(1.55 \pm 0.027)\ 10^{-4}$	2.65×10^{-4}
Off Site	α	48	$<5.4 \times 10^{-8}$	$<(2.4 \pm 1.5)\ 10^{-7}$	1.9×10^{-6}
	β-γ	48	3.38×10^{-5}	$(1.42 \pm 0.025)\ 10^{-4}$	2.05×10^{-4}

TABLE 3

NDFL PROCESS WATER RADIOACTIVITY DATA – 1973

Area	Activity	No. Samples	Gross Radioactivity (μCi/mℓ)	
			Average Value (95% Confidence Level)	Maximum Observed Value
NDFL	α	24	$<(2.6 \pm 2.6)\ 10^{-10}$	4.6×10^{-10}
	β-γ	24	$(3.4 \pm 0.79)\ 10^{-9}$	5.3×10^{-9}

Surface discharged waters from NDFL facilities drain southward into holding reservoirs on Rocketdyne Division SSFL property. When full, the main reservoir may be drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66-49 of September 21, 1966, an environmental sampling station was established in Bell Creek Canyon approximately 2.5 miles downstream from the south Rockwell International Corporation boundary. Samples, obtained and analyzed monthly,

include stream bed mud, vegetation, and water. Average radioactivity concentrations in Rocketdyne Reservoir and Bell Creek samples are presented in Table 4.

TABLE 4

BELL CREEK AND ROCKETDYNE SSFL RESERVOIR
RADIOACTIVITY DATA – 1973

Area	Activity	No. Samples	Gross Radioactivity		
			Average Value (95% Confidence Level)	Maximum Observed Value	% of Guide*
Bell Creek Mud No. 54 (μCi/gram)	α	12	$(3.4 \pm 1.1)\ 10^{-7}$	4.9×10^{-7}	-
	$\beta\gamma$	12	$(2.4 \pm 0.085)\ 10^{-5}$	2.8×10^{-5}	-
Bell Creek Vegetation No. 54 (μCi/gram-ASH)	α	12	$<(1.67 \pm 1.37)\ 10^{-7}$	4.40×10^{-7}	-
	$\beta\gamma$	12	$(1.47 \pm 0.0259)\ 10^{-4}$	2.14×10^{-4}	-
Bell Creek Vegetation No. 54 (μCi/gram dry wt)	α	12	$<(5.00 \pm 5.6)\ 10^{-8}$	1.75×10^{-7}	-
	$\beta\gamma$	12	$(3.76 \pm 0.13)\ 10^{-5}$	6.12×10^{-5}	-
Bell Creek Water No. 16 (μCi/mℓ)	α	12	$<(2.1 \pm 2.5)\ 10^{-10}$	2.7×10^{-10}	-
	$\beta\gamma$	12	$(2.7 \pm 0.75)\ 10^{-9}$	4.5×10^{-9}	2.7
SSFL Reservoir Water No. 6 (μCi/mℓ)	α	12	$<(2.3 \pm 2.5)\ 10^{-10}$	3.4×10^{-10}	-
	$\beta\gamma$	12	$(4.5 \pm 0.84)\ 10^{-9}$	6.4×10^{-9}	4.5
SSFL Reservoir Water No. 12 (μCi/mℓ)	α	12	$<(3.7 \pm 2.8)\ 10^{-10}$	1.9×10^{-9}	-
	$\beta\gamma$	12	$(5.6 \pm 0.90)\ 10^{-9}$	7.2×10^{-9}	5.6

*Guide 1×10^{-7} μCi/mℓ

Environmental air sampling for long-lived particulate alpha and beta-gamma radioactivity is performed continuously with automatic sequential samplers at both the Headquarters and NDFL sites. Air is drawn through an HV-70 filter

which is analyzed, after a minimum 72-hour decay period, for long-lived radioactivity. The average concentration of long-lived alpha and beta-gamma radioactivity is presented in Table 5.

TABLE 5

AIRBORNE RADIOACTIVITY DATA – 1973

Area	Activity	No. Samples	Average Value (95% Confidence Level)	Maximum Observed Value (daily)	% of Guide§
Headquarters (μCi/mℓ)	α*	715	$<(7.5 \pm 6.9)\ 10^{-15}$	2.2×10^{-14}	<12.5
	$\beta\gamma$†	715	$<(4.1 \pm 1.4)\ 10^{-14}$	1.2×10^{-13}	<4.1
NDFL (μCi/mℓ)	α*	2311	$<(7.2 \pm 6.8)\ 10^{-15}$	2.2×10^{-14}	<12
	$\beta\gamma$†	2311	$<(3.8 \pm 1.4)\ 10^{-14}$	1.2×10^{-13}	<3.8

*Alpha MDL 5.4×10^{-15} μCi/mℓ - Daily samples with activity levels of 0 to 5.4×10^{-15} μCi/mℓ recorded and averaged as 5.4×10^{-15} μCi/mℓ. Indicated average values are upper limits.
†Beta MDL 1.2×10^{-14} μCi/mℓ - Daily samples with activity levels of 0 to 1.2×10^{-14} μCi/mℓ are recorded and averaged as 1.2×10^{-14} μCi/mℓ.
§Guide 6×10^{-14} μCi/mℓ α
1×10^{-12} μCi/mℓ (β-γ)

Background radiation measurements are not reported for 1973 because of unreliable data due to problems with marginal equipment and inadequate annealing which resulted in inconsistent data and the appearance of latent dose phenomena.

Radioactivity concentrations in most sample types are generally commensurate with the concentrations observed in prior years, with a general downward trend in local environmental sample radioactivity concentrations. The environmental sample radioactivity concentrations reported and discussed herein are not attributed to Atomics Internationals's operations; rather it is felt to have been produced after September 1, 1961, by several world-wide nuclear detonations and also due to natural causes.

II. ENVIRONMENTAL MONITORING PROGRAM

A. GENERAL DESCRIPTION

Soil and vegetation sample collection and analysis for radioactivity were initiated in 1952 in the Downey, California, area where the Company was initially located. Environmental sampling was subsequently extended to the proposed Sodium Reactor Experiment (SRE) site in the Simi Hills in May of 1954. In addition, sampling was conducted in the Burro Flat area, southwest of SRE, where nuclear installations are currently in operation. The Downey area survey was terminated when the Company relocated to Canoga Park. The primary purpose of the environmental monitoring program is to survey environmental radioactivity adequately to ensure that Atomics International operations do not contribute significantly to environmental radioactivity. The locations of sampling stations are shown in Figures 4, 5, and 6, and in Table 6.

B. SAMPLING AND SAMPLE PREPARATION METHODS

Soil

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the top 1/2-inch layer of undisturbed ground surface. The soil samples are packaged in plastic containers and returned to the laboratory for analysis.

Sample preparation consists of transferring the soils to pyrex beakers and drying in a muffle furnace at approximately 500° C for eight hours. After cooling, the soil is sieved to obtain uniform particle size. Two-gram aliquots of the sieved soil are weighed and transferred to copper planchets. The soil is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted. Soil specific gravity ranges from 1.07 gram/mℓ to 1.41 gram/mℓ, and averages 1.24 gram/mℓ.

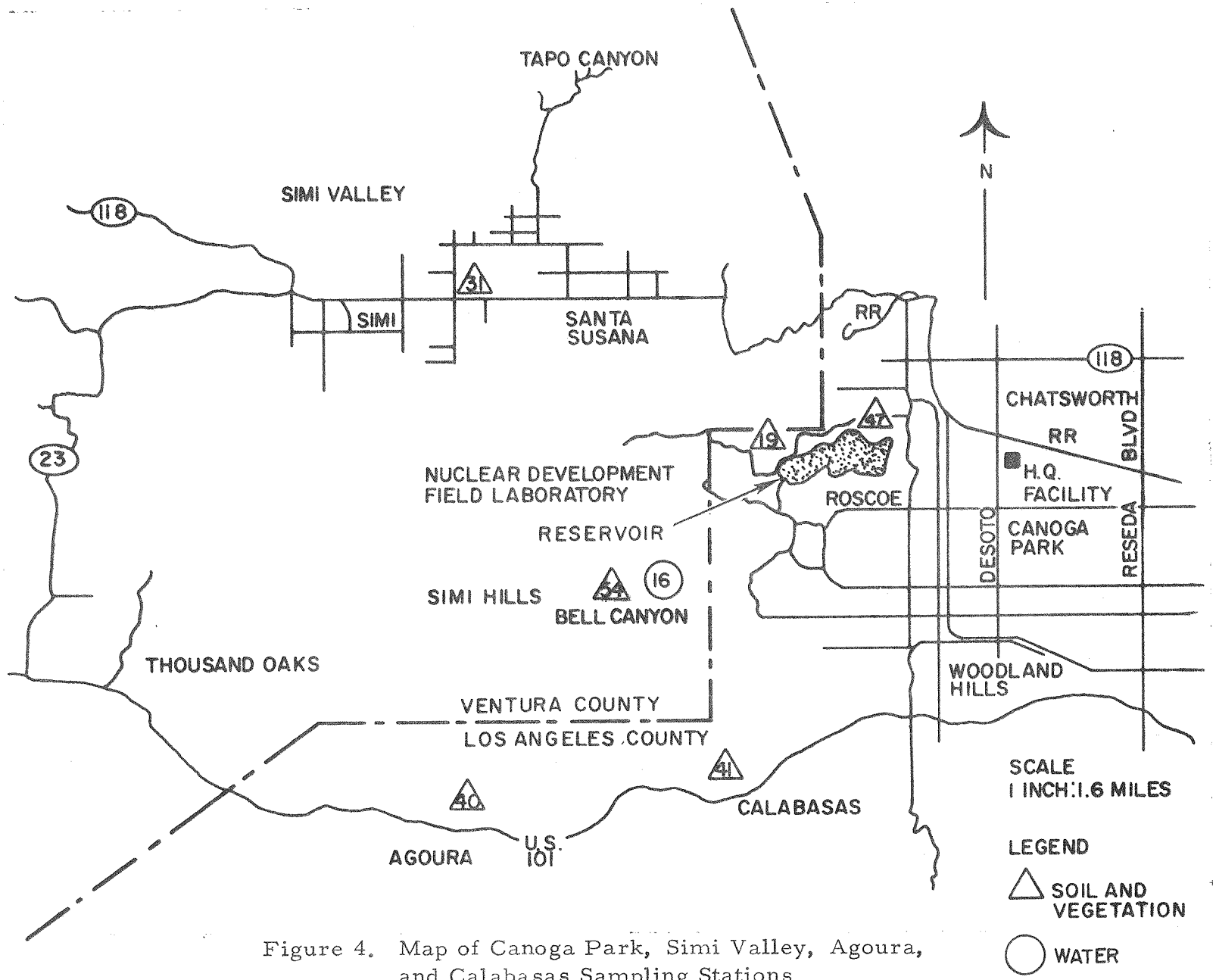

Figure 4. Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations

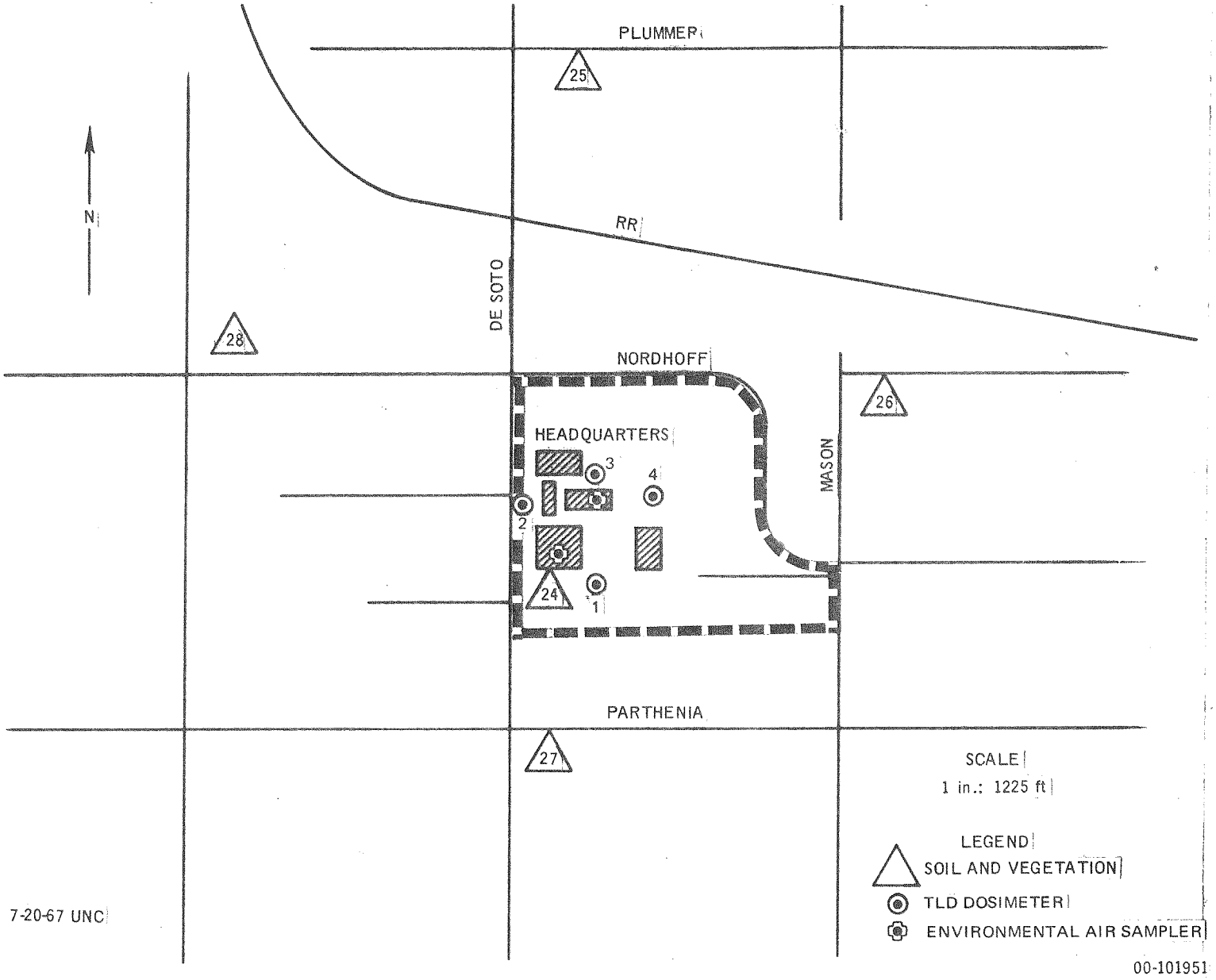

Figure 5. Map of Headquarters Vicinity Sampling Stations

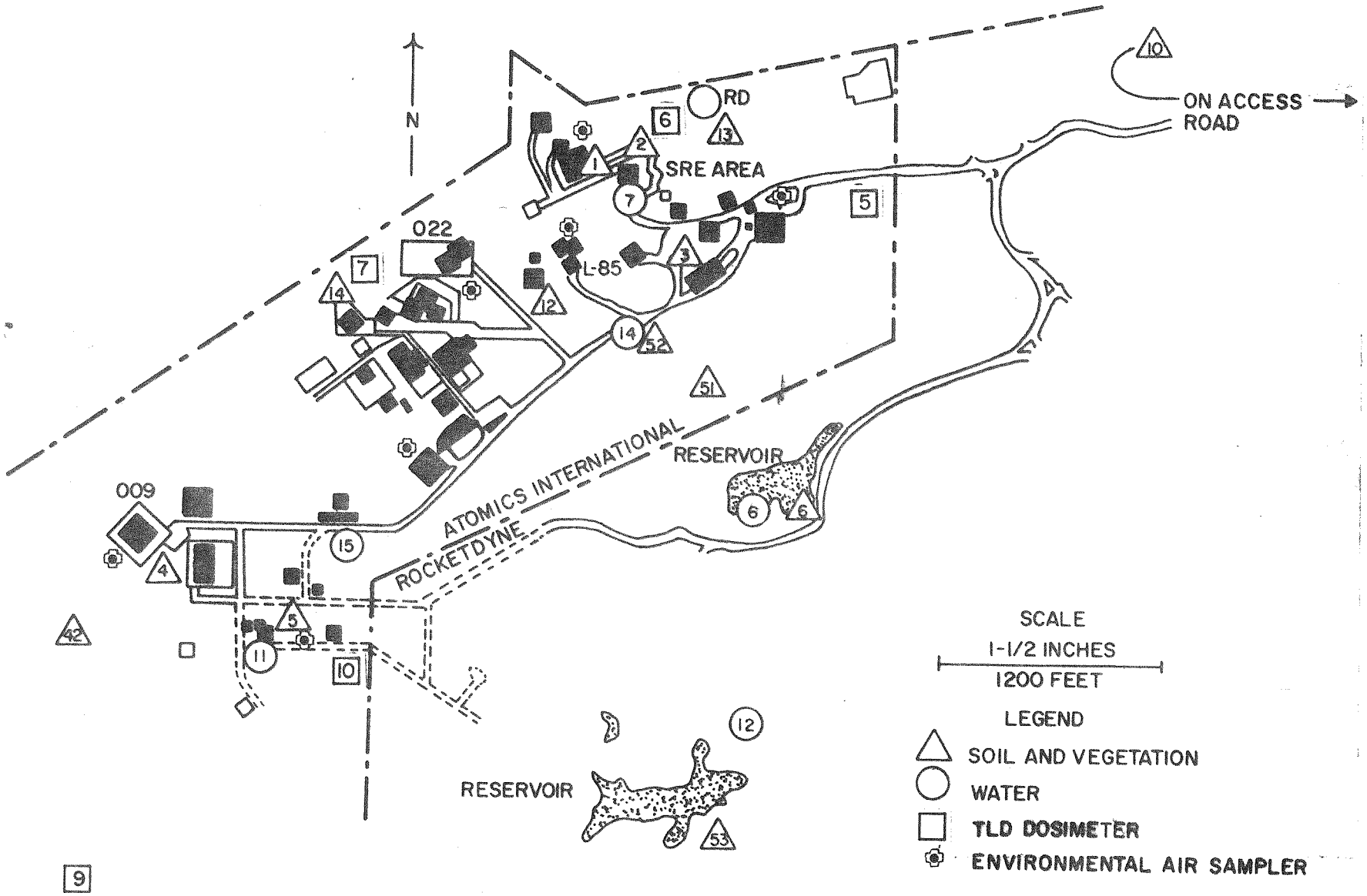

Figure 6. Map of NDFL Sampling Stations

TABLE 6

SAMPLE STATION LOCATIONS
(Sheet 1 of 2)

Station	Location
SV-1	SRE Reactor, NDFL
SV-2	SRE Perimeter Drainage Ditch, NDFL
SV-3	Bldg. 064 Parking Lot, NDFL
SV-4	Bldg. 020, NDFL
SV-5	Bldg. 363, NDFL
SV-6	Rocketdyne Reservoir, SSFL
SV-10	Santa Susana Site Access Road
SV-12	L-85 Reactor, NDFL
SV-13	Sodium Cleaning Pad, NDFL
SV-14	Below Bldg. 022, NDFL
SV-19	Santa Susana Site Entrance, Woolsey Canyon
SV-24	Atomics International Headquarters
SV-25	DeSoto Avenue and Plummer Street
SV-26	Mason Avenue and Nordhoff Street
SV-27	DeSoto Avenue and Parthenia Street
SV-28	Canoga Avenue and Nordhoff Street
SV-31	Simi Valley, Alamo Avenue and Sycamore Road
SV-40	Agoura — Kanan Road and Ventura Freeway
SV-41	Calabasas — Parkway Calabasas and Ventura Freeway
SV-42	Non-Radioactive Materials Disposal Area, NDFL
SV-47	Chatsworth Reservoir North Boundary
SV-51	Bldg. 029, NDFL
SV-52	Burro Flat Drainage Control Pond, G. Street and 17th Street, NDFL
SV-53	Top of Bell Canyon Below Rocketdyne Delta Pond Spillway, SSFL
SV-54	Bell Creek

SV — Soil and Vegetation Sample Station

TABLE 6

SAMPLE STATION LOCATIONS
(Sheet 2 of 2)

Station	Location
W-6	Rocketdyne Reservoir, SSFL
W-7	Process Water from Bldg. 003, NDFL
W-11	Process Water from Bldg. 363, NDFL
W-12	Rocketdyne Reservoir, SSFL
W-16	Bell Creek
A-1	Atomics International Headquarters, Bldg. 001 Roof
A-2	Atomics International Headquarters, Bldg. 004 Roof
A-3	Bldg. 009, NDFL
A-4	Bldg. 011, NDFL
A-5	Bldg. 012, NDFL
A-6	Bldg. 040, NDFL
A-7	Bldg. 074, NDFL
A-8	Bldg. 143, NDFL
A-9	Bldg. 363, NDFL
TLD-1	Atomics International Headquarters, South of Bldg. 102 on Fence
TLD-2	Atomics International Headquarters, West of Bldg. 001 on Gate to Plant Water Supply Enclosure
TLD-3	Atomics International Headquarters, Guard Post No. 1, Bldg. 201
TLD-4	Atomics International Headquarters, East Fence Gate
TLD-5	Bldg. 113, NDFL
TLD-6	SRE Retention Dam, NDFL
TLD-7	Electric Substation No. 719, NDFL
TLD-8	Property Line Gate, West End of H. Street, NDFL
TLD-9	Water Tank No. 701, NDFL
TLD-10	Bldg. 854, NDFL

W — Water Sample Station
A — Air Sample Station
TLD — Thermoluminescent Dosimeter Location

Vegetation

Vegetation samples obtained in the field are of the same perennial plant types wherever possible, generally sunflower or wild tobacco leaves. Vegetation leaves are stripped from plants and placed in ice cream cartons for transfer to the laboratory for analysis. Plant root systems are not normally analyzed.

Vegetation samples are first washed with tap water to remove foreign matter, and then thoroughly rinsed with distilled water. Washed vegetation is dried in tared beakers at 100°C for 24 hours for dry weight determination, then ashed in a muffle furnace at approximately 500°C for eight hours, producing a completely burned ash. One-gram aliquots of pulverized ash from each beaker are weighed and transferred to copper planchets. The vegetation ash is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted for alpha and beta radiation. The dry/ash weight ratio is used for the determination of the standard dry weight gross radioactivity concentration value.

Water

Surface water samples are obtained monthly at the NDFL and from Bell Creek. The water is drawn into one-liter polyethylene bottles and transferred to the laboratory.

Five-hundred mℓ of water are evaporated to dryness in crystallizing dishes at approximately 90°C. The residue salts are redissolved into distilled water and transferred to copper planchets, dried under heat lamps, and counted for radioactivity.

Air

Environmental air sampling is conducted continuously at the Headquarters and NDFL sites with automatic air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV-70 filter paper which is automatically changed at the end of each sampling period. The filters are removed from the sampler and counted for long-lived radioactivity following a minimum 72-hour decay period. The volume of a typical daily environmental air sample is approximately 25 cubic meters.

A graph of daily averaged airborne long-lived alpha and beta-gamma radioactivity concentrations detected at the Headquarters and NDFL facilities during 1973 is presented in Figure 7. The average beta-gamma concentration for each month is also indicated by horizontal bars. The graph shows few prominent peaks occurring during the first six months, and an increasing concentration trend through the summer and fall months.

C. COUNTING AND CALIBRATION PROCEDURES

Environmental soil, vegetation, water, and air samples are counted for alpha and beta-gamma radioactivity with a low-background proportional counting system capable of the simultaneous counting of both alpha and net beta radioactivity. The sample-detector configuration provides a nearly 2π geometry. The thin-window detector is continually purged with methane counting gas. A preset time mode of operation is used for all samples; however, an overriding preset count mode is available to limit the counting time for high activity samples. The minimum detection limits shown in Table 7 were determined by using typical values for counting time, system efficiency, background count rates (approximately 0.05 cpm α and 1.0 cpm $\beta\gamma$) and sample size. In addition, the minimum statistically significant amount of radioactivity, irrespective of sample configuration, is established as that amount equal in count rate to three times the standard deviation of the system background count rate.

TABLE 7

MINIMUM RADIOACTIVITY DETECTION LIMITS

Sample	Activity	Minimum Detection Limits*
Soil	α	$(5.1 \pm 6.1)\ 10^{-8}$ μCi/gram
	$\beta\gamma$	$(2.2 \pm 2.2)\ 10^{-7}$ μCi/gram
Vegetation	α	$(1.0 \pm 1.2)\ 10^{-7}$ μCi/gram-ASH
	$\beta\gamma$	$(3.5 \pm 3.5)\ 10^{-7}$ μCi/gram-ASH
Water	α	$(2.1 \pm 2.4)\ 10^{-10}$ μCi/mℓ
	$\beta\gamma$	$(6.3 \pm 6.3)\ 10^{-10}$ μCi/mℓ
Air	α	$(5.4 \pm 6.4)\ 10^{-15}$ μCi/mℓ
	$\beta\gamma$	$(1.2 \pm 1.2)\ 10^{-14}$ μCi/mℓ

*95% Confidence Level

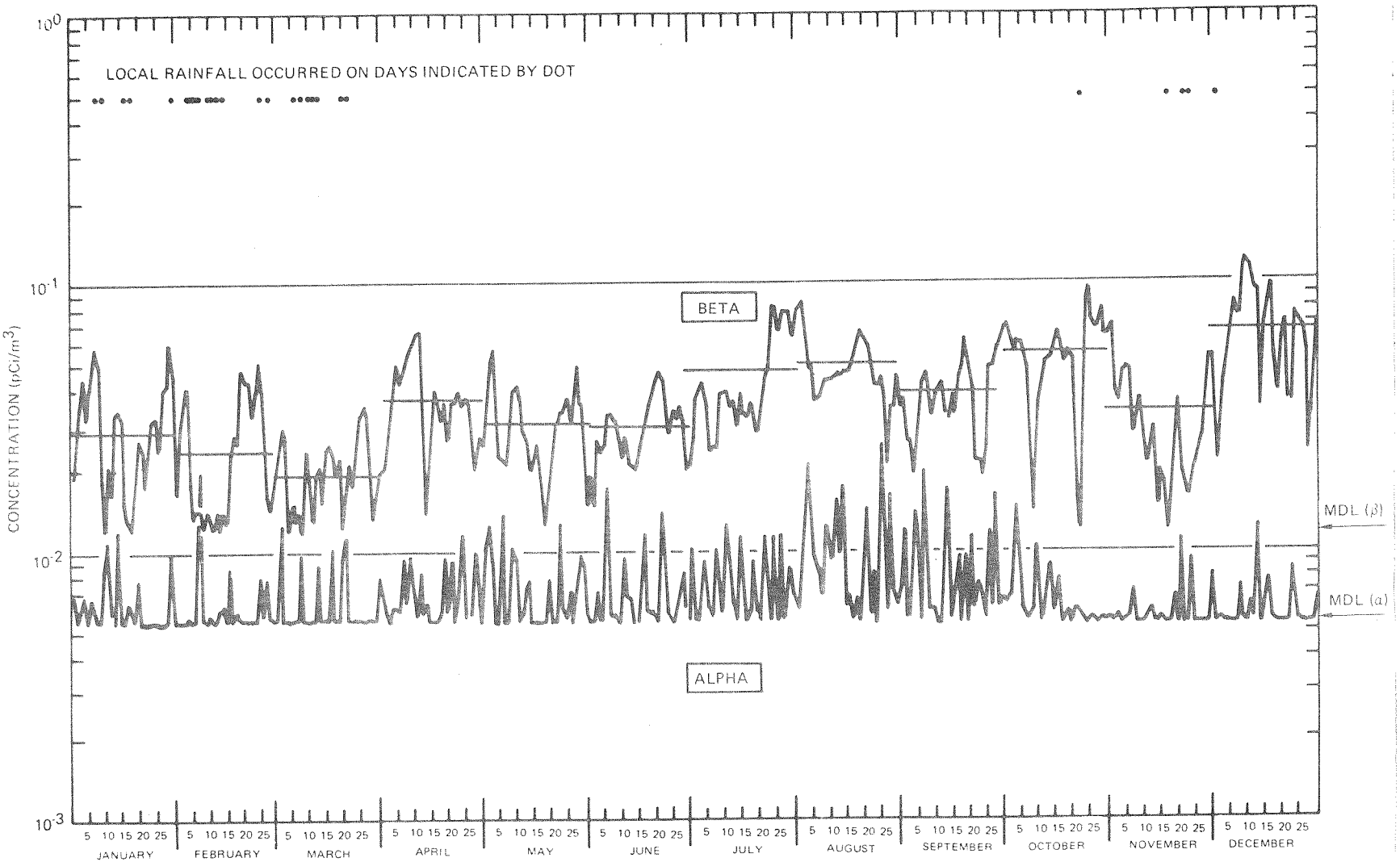

Figure 7. Daily Averaged Long-Lived Airborne Radioactivity Headquarters and NDFL – 1973

Counting system efficiencies are determined routinely with RaD+E+F (with alpha absorber), Th^{230}, and U^{235} standard sources, and with K^{40} in the form of standard reagent grade KCl, which is used to simulate soil and vegetation samples. Self-absorption standards are made by dividing sieved KCl into samples increasing in mass by 200-milligram increments from 100 to 3000 milligrams. The samples are placed in copper planchets of the type used for environmental samples and counted. The ratio of sample activity to the observed net count rate for each sample is plotted as a function of sample weight. The correction factor (ratio) corresponding to sample weight is obtained from the graph. The product of the correction factor and the net sample count rate yields the sample activity (dpm). This method has been proved usable by applying it to variously sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fall within the expected statistical counting error.

III. EFFLUENT DATA

Radioactive effluents are generated at Atomics International facilities as the result of operations performed under contract to the USAEC, under Special Nuclear Materials License SNM-21, and under State of California Radioactive Material License 0015-59. The specific facilities are identified as Buildings 001 and 004 at the Headquarters site, and Buildings 003, 020, and 055 at the Santa Susana site.

A. FACILITY DESCRIPTIONS

Building 001

Operations at Building 001 which generate radioactive effluents consist of production operations associated with the manufacture of enriched uranium fuel elements. Only particulate radioactive material contained in the gaseous effluents is released from the facility. Liquid wastes are released to the sanitary sewerage system.

Building 004

Operations at Building 004 which generate radioactive effluents consist of research studies in physics and chemistry, and the chemical analysis of small quantities of fuel materials, usually limited to a few grams. Only particulate radioactive material contained in gaseous effluent is released from the facility. Liquid wastes are released to the sanitary sewerage system.

Building 003

Building 003, currently deactivated, contains a small hot-cell previously used for reactor fuel element examination. Only solid particulate material contained in gaseous effluent is released from the facility. No liquid effluents are released from the facility.

Building 020

Operations at Building 020 which generate radioactive effluents consist of hot-cell examination of irradiated nuclear fuels and reactor components. Solid particulate material as well as radioactive gases may be contained in the gaseous effluent from the facility, depending on the operations being performed and the radiation history of the irradiated fuel. The chemical form of such effluent may be U metal, UO_2, UC, mixed fission products, and irradiated structural components. No liquid effluents are released from the facility.

Building 022

Operations at Building 022 which generate radioactive effluents consist of the processing, packaging, and temporary storage of liquid and dry radioactive waste materials for disposal. Only particulate radioactive material contained in gaseous effluent is released from the facility. No liquid effluent is released from the facility.

Building 055

Operations at Building 055 which generate radioactive effluents consist of fabrication of plutonium and plutonium-uranium fuel pins. Only solid particulate radioactive material contained in gaseous effluents are released from the facility. No liquid effluents are released from the facility.

B. TREATMENT AND HANDLING

Waste streams released to unrestricted areas are limited in all cases to gaseous effluents.

The level of radioactivity contained in all gaseous effluents is reduced to the lowest practicable by releasing the effluents through certified HEPA filters. These effluents are sampled for particulate radioactive materials by means of continuous stack exhaust samplers. In addition, stack monitors are provided at Building 020, 022, and 055 which provide automatic alarm capability in the event of the release of gaseous activity from Building 020 or 022, or particulate activity from Building 055. The HEPA filters used for filtering gaseous effluents are 99.95% efficient for particles of 0.3 micron diameter.

The average concentration and total curies of radioactivity in gaseous effluent released to unrestricted areas is shown in Table 8.

TABLE 8

GASEOUS EFFLUENT RELEASED TO UNRESTRICTED AREAS

Building	Point of Release	Volume (ft^3)	Activity	Minimum* Detection Limit ($\mu Ci/m\ell$)	Average Concentration ($\mu Ci/m\ell$)	Maximum Concentration ($\mu Ci/m\ell$)	Total Activity Released (Ci)
001	Stack Exit	3.8×10^{10}	α	4.0×10^{-16}	$<1.1 \times 10^{-15}$	1.0×10^{-14}	$<1.4 \times 10^{-6}$
			β	1.6×10^{-15}	$<2.6 \times 10^{-15}$	2.6×10^{-14}	$<3.2 \times 10^{-6}$
004	Stack Exit	6.9×10^{10}	α	6.3×10^{-16}	$<2.1 \times 10^{-15}$	5.7×10^{-14}	$<4.9 \times 10^{-6}$
			β	2.5×10^{-15}	$<3.7 \times 10^{-15}$	4.0×10^{-14}	$<7.0 \times 10^{-6}$
003	Stack Exit	9.8×10^{9}	α	1.7×10^{-16}	$<1.8 \times 10^{-16}$	3.4×10^{-16}	$<4.8 \times 10^{-8}$
			β	6.3×10^{-16}	$<1.4 \times 10^{-14}$	1.4×10^{-13}	$<3.6 \times 10^{-7}$
020	Stack Exit	2.1×10^{10}	α	8.3×10^{-17}	4.6×10^{-16}	3.3×10^{-15}	2.7×10^{-7}
			β	3.1×10^{-16}	1.1×10^{-14}	2.7×10^{-14}	6.7×10^{-6}
022	Stack Exit	1.0×10^{10}	α	2.1×10^{-16}	$<4.9 \times 10^{-16}$	2.4×10^{-15}	$<1.4 \times 10^{-7}$
			β	7.7×10^{-16}	$<1.6 \times 10^{-14}$	9.4×10^{-14}	$<4.6 \times 10^{-6}$
055	Stack Exit	1.6×10^{10}	α	1.8×10^{-16}	$<2.9 \times 10^{-16}$	1.6×10^{-15}	$<1.3 \times 10^{-7}$

*95% Confidence Level

APPENDIX A

A COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1973 WITH PREVIOUS YEARS

This section compares environmental monitoring results for the calendar year 1973 with previous annual data. The annual average radioactivity concentrations determined in all sample types are presented in the following tables.

SOIL RADIOACTIVITY DATA – 1964 THROUGH 1973

Year	On Site – Average μCi/gram x 10^{-6}			Off Site – Average μCi/gram x 10^{-6}		
	No. Samples	α	β-γ	No. Samples	α	β-γ
1973	144	0.57	25.	48	0.51	24.
1972	144	0.56	25.	48	0.57	24.
1971	144	0.55	25.	48	0.53	23.
1970	144	0.47	27.	48	0.48	25.
1969	144	0.42	27.	48	0.42	25.
1968	144	0.47	26.	48	0.48	26.
1967	144	0.42	28.	48	0.39	24.
1966	144	0.41	29.	48	0.44	25.
1965	144	0.46	36.	142	0.47	29.
1964	152	0.46	32.	299	0.44	26.

VEGETATION RADIOACTIVITY DATA – 1964 THROUGH 1973

Year	On Site – Average μCi/gram Ash x 10^{-6}			Off Site – Average μCi/gram Ash x 10^{-6}		
	No. Samples	α	β-γ	No. Samples	α	β-γ
1973	144	<0.24	155.	48	<0.24	142.
1972	144	0.23	145.	48	0.36	125.
1971	144	0.24	165.	48	0.31	132.
1970	144	0.33	159.	48	0.30	142.
1969	144	0.40	165.	48	0.36	144.
1968	144	0.51	158.	48	0.51	205.
1967	144	0.62	286.	48	0.39	413.
1966	144	0.37	169.	48	0.37	123.
1965	144	0.56	162.	142	0.61	138.
1964	154	0.50	211.	293	0.51	181.

NDFL PROCESS WATER RADIOACTIVITY DATA – 1964 THROUGH 1973

Year	No. Samples	Alpha	Beta-Gamma
		Average μCi/mℓ x 10^{-9}	Average μCi/mℓ x 10^{-9}
1973	24	<0.26	3.4
1972	24	0.22	3.7
1971	24	0.28	4.9
1970	24	0.18	5.3
1969	24	0.11	5.0
1968	24	0.16	5.0
1967	24	0.13	6.1
1966	24	0.13	4.6
1965	24	0.22	6.0
1964	23	0.17	5.2

BELL CREEK AND ROCKETDYNE SSFL RESERVOIR RADIOACTIVITY DATA – 1966 THROUGH 1973

Year	SAMPLES														
	Bell Creek Mud 54			Bell Creek Vegetation 54			Bell Creek Water 16			Reservoir No. 6 Water			Reservoir No. 12 Water		
	No. Samples	Average μCi/gram x 10^{-6}		No. Samples	Average μCi/gram – Ash x 10^{-6}		No. Samples	Average μCi/mℓ x 10^{-9}		No. Samples	Average μCi/mℓ x 10^{-9}		No. Samples	Average μCi/mℓ x 10^{-9}	
		α	β-γ		α	β-γ		α	β-γ		α	β-γ		α	β-γ
1973	12	0.34	24.	12	<0.17	147.	12	<0.21	2.7	12	<0.23	4.5	12	<0.37	5.6
1972	12	0.32	22.	12	0.12	139.	12	0.20	2.5	12	0.22	5.3	12	0.22	5.5
1971	12	0.36	23.	12	0.19	128.	12	0.15	3.8	12	0.18	6.2	12	0.16	6.4
1970	12	0.44	24.	12	0.23	165.	12	0.15	3.7	12	0.15	6.9	12	0.12	7.4
1969	12	0.35	27.	12	0.28	166.	12	0.04	4.0	12	0.07	5.9	11	0.10	5.7
1968	11	0.32	24.	11	0.39	170.	8	0.05	4.6	11	0.23	8.1	12	0.33	7.7
1967	12	0.40	24.	12	0.38	180.	12	0.07	5.8	12	0.19	6.6	10	0.17	7.0
1966	3	0.39	25.	3	1.1	108.	3	0.75	2.5	9	0.11	5.8	8	1.1	6.3

AIRBORNE RADIOACTIVITY DATA —
1964 THROUGH 1973

Year	Headquarters Average μCi/mℓ x 10^{-12}			NDFL Average μCi/mℓ x 10^{-12}		
	No. Samples	α	β-γ	No. Samples	α	β-γ
1973	715	<0.0075	<0.041	2311	<0.0072	<0.038
1972	708	0.0085	0.14	2430	0.0086	0.14
1971	730	0.0087	0.30	2476	0.0086	0.33
1970	668	-	0.34	2434	-	0.36
1969	687	-	0.27	2364	-	0.26
1968	650	-	0.32	2157	-	0.32
1967	712	-	0.39	2400	-	0.41
1966	706	-	0.18	2205	-	0.17
1965	483	-	0.83	1062	-	0.21
1964	355	-	2.7	Insufficient Data		

APPENDIX B
REFERENCES

1. AEC Manual Chapter 0524, Appendix
2. Code of Federal Regulations, Title 10, Part 20
3. California Administrative Code, Title 17, Public Health

APPENDIX C
EXTERNAL DISTRIBUTION

1. Bureau of Radiological Health, California Department of Public Health
2. Radiological Health Division, Los Angeles County Health Department
3. U.S. Atomic Energy Commission, San Francisco Operations Office
4. Gordon Facer, MA AEC-HQ
5. Andrew J. Pressesky, RDT AEC-HQ
6. James Miller, BER AEC-HQ
7. AEC-HQ Library, Attention: Charles Sherman